

EVALUATING DEBRIS REMOVAL FROM CIRCULAR HOLDING TANKS BY LIFTING THE HOLDING TANK SCREEN AT THE TRACY FISH COLLECTION FACILITY

Investigators

Brandon J. Wu

*Fisheries Biologist
Tracy Fish Collection Facility
Bureau of Reclamation
Byron, CA 94514
bwu@usbr.gov*

Brent Bridges

*Fisheries Biologist
Tracy Fish Collection Facility
Bureau of Reclamation
Byron, CA 94514
bbridges@usbr.gov*

Summary

The Bureau of Reclamation's (Reclamation) Tracy Fish Collection Facility (TFCF) was built in 1956 to remove Chinook salmon (*Oncorhynchus tshawytscha*) and striped bass (*Morone saxatilis*) ≥ 20 mm fork length (FL) from the Delta-Mendota Canal (DMC). Once fish are removed from the DMC, they are held in concrete holding tanks (6.1 m diameter x 5 m deep), equipped with lift-able cylindrical wire-mesh holding tank screens (2.4 m diameter x 5 m deep), for 8–12 h and then transported by truck for release in the northern Sacramento-San Joaquin Delta (SSJD) beyond the immediate influence of the C.W. "Bill" Jones Pumping Plant (JPP) in a process known as the haul-out. The number of fish salvaged and hauled-out at the TFCF is estimated by performing a fish-count, in which a sub-sample of the water flowing into the tanks is taken every 2 hours. Along with fish, large amounts of Brazilian Elodea (*Egeria densa*) or woody debris (*i.e.*, sticks, twigs, root balls) can accumulate in the holding tanks at the TFCF. This debris can be a major problem, impacting overall fish survival when the fish-count or haul-out buckets clog and can also complicate fish-count and haul-out procedures when extra labor is needed to remove the debris from clogged buckets (J. Imai 2009, personal communication).

In this study, we will evaluate if quickly lifting and reseating the holding tank screen (Holding Tank Screen Lift, HTSL) to allow debris to pass under the screen and away from the fish is an effective debris removal technique during the fish-count and haul-out processes. This action may sacrifice a small percentage of the fish in the holding tank but allow the remaining fish to be safely transported to the

haul-out truck or be more accurately counted in the fish-count station, resulting in overall improved fish survival and more accurate estimates of fish salvage. This allows for the appropriate determination of fish-haul frequency and promotes acceptable fish transport conditions and is important for estimating salvage of listed species.

This project was started in 2006. Work on this project was delayed in 2007 due to construction activity. Little work was completed during the 2008, 2009, and 2010 seasons due to larval smelt sampling activity at the TFCF. Minimal progress was made during the 2011 research period due to the fact that other projects took precedence. The majority of data collection for this project was completed in 2012 and a draft report is currently being prepared. Upon completion of the report, this debris removal process could be implemented at the TFCF as an alternative to expensive screening and debris removal techniques that require extensive testing and engineering design. This project focused on two debris types: 1) green, leafy debris such as *E. densa* and 2) woody debris. Data collection has been completed for both debris types and a draft report is currently being prepared. A summary of preliminary data is included below.

The average fish count station capacity for green and woody debris was 7.6 kg and 25.9 kg, respectively. The fish count bucket was found to clog when there was between 16.3 kg and 21.3 kg of green debris and between 51.0 kg and 58.0 kg of woody debris present. The haul-out bucket was determined to have a clogging capacity of between 82.5 kg and 90.0 kg of green debris. The clogging capacity of the haul-out bucket for woody debris has yet to be determined although it is known to be >100 kg.

The average minimum amount of extra time that it takes to perform the “Holding Tank Screen Lift” during the fish count and haul-out processes was determined to be 4.4 min (4.4–4.6 min) and 4.6 min (4.5–4.7 min), respectively. These times do not include rinsing or flushing of debris. It is anticipated that necessary rinsing and/or flushing during the HTSL process will require additional time.

It was determined that there was less green and woody debris in the holding tank after performing the HTSL. On average, 49.5% (26.9–91.8%) of green debris and 81.5% (38.5–99.2%) of woody debris was removed in Sample #1 leaving, on average, 50.6% (8.2–73.1%) of green debris and 18.5% (0.8–61.5%) of woody debris in Sample #2.

The HTSL prevented the fish count station from filling when there was approximately 10–18 kg of green debris and approximately 26–66 kg of woody debris in the holding tank. The HTSL prevented the fish count bucket from clogging when there was approximately 22–43 kg of green debris and 58–77 kg of woody debris present in the holding tank. The range of green debris in the holding tank in which the HTSL prevented the haul-out bucket from clogging was

approximately 95–135 kg. The range of woody debris in the holding tank in which the HTSL prevented the haul-out bucket from clogging has yet to be determined.

When the HTSL was completed with green debris an average of 30% of all fish were collected in Sample #1 and 70% in Sample #2. Similarly, with woody debris Sample #2 had a greater percentage of fish collected (95.9%) than in Sample #1 (4.1%). Repetitions performed with woody debris when large numbers of Sacramento splittail and common carp were salvaged at the TFCF also suggest that there is a difference in the number of fish collected in the 2 samples with, on average, 7.2% of fish being collected in Sample #1 and 92.8% of fish collected in Sample #2. Although performing the HTSL with both debris types was found to retain the majority of fish, a higher percentage of fish were saved when the method was used with woody debris.

For both debris types and debris loads combined, there were differences in the number of fish and the lengths of certain fish species in the two samples when conducting the HTSL. There was a difference in the total number of fish collected in Sample #1 and Sample #2 with more fish collected in Sample #2 (83.0%). Certain fish species such as bluegill, common carp and threadfin shad were extremely likely to be retained in Sample #2. Larger fish were collected in Sample #2 except for Sacramento splittail and bluegill which exhibited a trend in which significantly larger fish were collected in Sample #1. Chinook salmon and largemouth bass were not significantly larger in length in either sample.

Retention of fish (Sample #2) seemed to be dependent on species and their inherent behavior. Retention of pelagic fish such as American shad, threadfin shad, and striped bass was high at 94.4%, 96.4%, and 93.8%, respectively. Because of these species' open-water nature, they are less likely to congregate and take cover around the holding tank screen where debris accumulates prior to draining and performing the HTSL. In contrast, the retention of benthic fish such as white catfish, channel catfish, and prickly sculpin was lower at 64.8%, 54.2%, and 33.3%, respectively. Because of these species' bottom-oriented nature, they are more likely to congregate around the holding tank screen. Furthermore, the holding tank's conical-shaped bottom acts to funnel these benthic fish toward the center during draining. Retention of littoral species such as common carp, largemouth bass, bluegill, and Sacramento splittail at 71.8%, 86.1%, 81.9%, 65.8%, respectively, was less compared to pelagic fish but more than benthic fish. Littoral species often are associated with vegetation; therefore, these species are likely to take cover in free-floating debris and debris that accumulated around the holding tank screen during draining. Retention of Chinook salmon, a largely pelagic species, was unexpectedly lower (32.0%) and comparable to benthic fish. This may be due to Chinook salmon's reaction to the HTSL process. Due to the strong swimming capability of Chinook salmon (Bell, 1986) and their attraction to mild turbulence and higher flows (Coutant, 1998), it is possible that they are able to quickly swim under the holding tank screen during the 1 s lift.

Problem Statement

At the TFCF, fish are collected and held in 6.1-m diameter holding tanks for 8–12 h before they are released in a process known as the haul-out. During the 8–12 h collection and holding time, large amounts of Brazilian elodea or woody debris can accumulate in the holding tanks and may impact fish survival when the fish count or haul-out buckets clog or complicate the fish-count and haul-out procedures when extra labor is needed to remove the debris from the clogged buckets (Imai 2009, personal communication). Large amounts of debris in the fish-count station can also cover or hide fish, which, when uncounted, could potentially result in reduced accuracy of fish salvage estimates used to determine when haul-outs are necessary. The primary objective of this study is to determine if quickly lifting and reseating the holding tank screen prior to collecting fish in the fish-count and haul-out buckets (HTSL) is a cost efficient, effective and time conserving debris removal technique.

Goals and Hypotheses

Goals:

1. Determine the range of debris load in the holding tank in which the HTSL prevents each bucket from clogging.
2. Determine the range of debris load in the holding tanks in which the percent fish loss for the HTSL is below that for the routine fish-count process.
3. Determine the range of debris load in the holding tanks in which the time it takes to complete the fish-count and haul-out processes, using the HTSL is less than that required to complete the fish-count or haul-out processes using the normal method.

Hypotheses:

1. The amount of debris remaining in the holding tanks during the fish-count and haul-out processes will be the same for normal operation and the HTSL.
2. The percent of fish retained in the fish-count and haul-out buckets will be the same for normal operations and the HTSL.
3. The amount of time to complete the entire fish-count and haul-out processes will be equal for normal operation and when performing the HTSL.

Materials and Methods

Fish-Count Station, Fish-Count Bucket, and Haul-Out Bucket Clogging Evaluations

The amount of green and woody debris it takes to fill the 44.1-L fish-count station (48.3 cm diameter x 24.1 cm deep) was estimated by injecting each type of debris into the count station until the debris level was flush with the top of the station. A 0.04 cubic meter capacity polyethylene fish basket (48.3 cm top diameter, 36.8 cm bottom diameter, 36.8 cm height, Memphis Net & Twine Co., Memphis, TN) with 0.8 cm x 1.4 cm basket openings was placed on a tared scale (CAS BW-30 Digital Bench Scale, CAS-USA Corp., East Rutherford, NJ). Debris was transferred from the fish-count station to the polyethylene fish basket and a total weight was obtained. All weights were obtained with debris that was damp but not dripping. This process was completed three times for each debris type and averaged to obtain an estimate of the amount of each type of debris necessary to fill or clog the fish count station.

The amount of green and woody debris to clog the fish-count and haul-out buckets was estimated by injecting known amounts of debris into each of the buckets, filling the buckets with water, and observing if the buckets clogged during the release of the sample into a 355.6 cm long x 73.7 cm wide x 76.2 cm deep trough. If the buckets did not clog with a certain debris load, an amount 50% higher was injected and tested; if the buckets clogged with a certain debris load, an amount 50% lower was injected and tested. This process was followed until the lowest amount of each type of debris that clogged the fish count and haul-out bucket 3 consecutive times and the greatest amount of each type of debris that did not clog the fish count and haul-out bucket 3 consecutive times was determined.

Estimation of Extra Time

The minimum amount of extra time it takes to perform the steps of the HTSL during the fish-counts was determined using a R&M LOADMATE LM20, 460V, 3 ton, two-speed electric chain hoist (R&M Materials Handling, Inc., Springfield, OH) and an empty (no water or fish) fish-count bucket. The time it took two different operators (3 trials each) to hoist the empty fish-count bucket from holding tank drain pit #2 to the fish-count station (seated on the fish count station) and back to holding tank drain pit #2 was determined. Holding tank #2 was chosen as a starting point because it is the holding tank where fish for the fish-counts are usually collected.

The minimum amount of extra time it takes to perform the HTSL during haul-outs at the TFCF was determined using a R&M LOADMATE LM20, 460V, 3 ton, two-speed electric chain hoist and an empty (no water or fish) haul-out bucket. The time it took two different operators (3 trials each) to hoist the empty haul-out bucket from holding tank drain pit #3 to the fish-haul truck (seated on the front

top hatch of the truck) and back to holding tank drain pit #3 was determined. Holding tank #3 was chosen because this is the holding tank usually used to hold salvaged fish until they are hauled-out.

Holding Tank Screen Lift Evaluation

Various fish species including American shad (*Alosa sapidissima*), bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), Chinook salmon, common carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), prickly sculpin (*Cottus asper*), Sacramento splittail (*Pogonichthys microlepidotus*), threadfin shad (*Dorosoma petenense*), and white catfish (*Ameiurus catus*) along with varying loads of green and woody debris were used in order to determine the amount of debris removed and the proportion of fish lost during a HTSL. Debris and fish loads tested were obtained by either injecting debris and fish into the holding tank or allowing debris and fish to be naturally collected into the holding tank for a specified collection period. After debris injection or the specified collection period, the fish-count or haul-out bucket was inserted into the holding tank drain pit and the holding tank was drained to an approximate depth of 0.6 m. The HTSL was conducted twice with a duration of approximately 1 s per lift. After collection of debris, the bucket was lifted out of the drain pit and contents, referred to as Sample #1, dumped into either the fish-count station or a 355.6 cm long x 73.7 cm wide x 76.2 cm deep trough for processing. The debris was transferred to a 0.04 cubic meter capacity polyethylene fish basket with mesh opening of 0.8 cm x 1.4 cm. The fish were identified, measured, and placed in an 18.9-L black bucket with oxygenated water. The weight of debris and fish from Sample #1 were measured with a CAS BW-30 Digital Bench Scale. After Sample #1 was processed, the bucket was re-lowered into the holding tank drain pit and all the remaining fish and debris in the holding tank, referred to as Sample #2, were washed into the bucket, lifted, and processed in the same manner as the first sample. The amount of debris and number of fish in each of the two samples were used to determine the percentage of debris removed and the percentage of fish lost. The amount of green and woody debris in each of the two samples, as well as the fish-count station, fish-count bucket, and haul-out bucket clogging capacities, allowed for the estimation of the range in the amount of each type of debris in which performing the HTSL prevents each piece of equipment from filling or clogging.

Data Analysis

This study was designed to provide a point estimate and 95% CI for debris removal and fish loss in Sample #1. Regression will be used to make comparisons between the total amount of green and woody debris in the holding tank and the amounts collected in Sample #1 and Sample #2. Numbers of fish, fish species, and lengths of individual species collected in Sample #1 and Sample #2 were also intended to be compared using Two-Sample t-tests. Despite this, it was determined that the data violated the assumption of normality that is

necessary for parametric analysis and a nonparametric alternative to two-sample t-tests, the Mann-Whitney test (rank sum test), was used to analyze data by comparing population medians. All statistical tests were conducted using MiniTab software (MiniTab version 15, State College, Pennsylvania).

Coordination and Collaboration

All experiments were coordinated with the TFCF Fish Diversion Workers and the TFCF Biology staff. Minimal progress was made during the 2011 research period due to the fact that other projects took precedence. The majority of debris removal research with *E. densa* and woody debris was completed in 2012.

Endangered Species Concerns

No ESA listed species will be targeted during the period of this study. It is possible that there will be incidental “take” of ESA listed salmon, steelhead and/or delta smelt. If collected, ESA listed salmon, steelhead and delta smelt will be measured and released alive back into the normal salvage operations.

Dissemination of Results (Deliverables and Outcomes)

A Tracy Series Report volume will be prepared and published upon completion of this study. Updates and presentations of progress will be provided internally and upon request by TTAT and other interagency technical forums. We will have the data analysis for the *E. densa* and woody debris removal trials completed by December 2012 and will have a draft report finished by April 2013 for internal review. A final draft report for TTAT review will be completed by the end of June 2013.

Literature Cited

- Arthur, J.F., M.D. Ball, and S.Y. Baughman. 1996. *Summary of Federal and State Water Project Environmental Impacts in the San Francisco Bay-Delta Estuary, California*. Pages 445–495 in J.T. Hollibaugh, editor. San Francisco Bay: The Ecosystem, Further Investigations into the Natural History of San Francisco Bay and Delta With Reference to the Influence of Man. Pacific Division of the American Association for the Advancement of Science, California Academy of Sciences, San Francisco, California
- Imai, J. 2009. Bureau of Reclamation, Tracy Fish Collection Facility, Byron, California, personal communication.